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Range Cattle Production, 3

BIRTH TO WEANING

A Literature Review

By

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RANGE CATTLE PRODUCTION

A Literature Review

Section III

BIRTH TO WEANING

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TABLE OF CONTENTS

RANGE CATTLE PRODUCTION

BIRTH TO WEANING

Economic Considerations

The data which follow have been presented to show the importance of the percent calf crop and weaning weight (125).

If the total cost of keeping each cow for one year is $100, the cost of each weaned calf, depending on the percent calf crop, will be:

Percentage Calf Crop	Cost Per Calf
100	$100
90	111
80	125
70	143
60	167

If the total annual cost for each cow amounts to $100, the cost per hundred pounds of weaned calf, depending on percent calf crop and the weaned weight of the calf, will be:

Percent Calf Crop	Average Weaned Weight of Calf (lbs.)	Cost of Calf Per Cwt.
100	600	$16.67
	500	20.00
	400	25.00
80	600	20.83
	500	25.00
	400	31.25
60	600	27.78
	500	33.33
	400	41.67

A summary of the operations of 1,200 range producers in the eleven western states indicated that 29 percent sold calves primarily, 54 percent sold yearlings or two-year-olds, 89 percent of the cattle were sold on a weight basis, and 70 percent of the animals sold went to market during the three fall months of September, October, and November (124). There was a tendency for the small producers to operate cow-and-calf outfits, while the larger operators sold yearlings.

The average weights of cattle sold in the region were (124):

Calves	383 pounds
Steers	793 pounds
Heifers	654 pounds
Cows	951 pounds

Heritability Estimates - Weaning Factors

Weaning Weight

Method	Heritability	Breed	Reference
Paternal half-sib correlation	.26	Hereford	(48)
Paternal half-sib correlation	.52	Hereford	(48)
Paternal half-sib correlation	.28	Hereford	(72)
Paternal half-sib correlation	.23	Hereford	(121)
Intra-sire correlation	.12	Hereford	(75)
Sire-progeny regression	0	Hereford	(75)
	.28	Hereford	(78)
Sire-offspring regression	0	Brahman-Angus	(29)
Paternal half-sib correlation	.19	Brahman-Angus	(29)
	.64	Chiana	(18)
Dam-offspring regression	-.06	Hereford	(116)

Weaning Score

Intra-sire correlation	.31	Hereford	(73)
Dam-offspring regression	.26	Hereford	(116)
Intra-sire correlation	.53	Hereford	(76)
Half-sib correlation	.28	Hereford	(72)
Dam-offspring regression	.50	Angus	(86)
Half-sib correlation	.30	Angus	(86)
Half-sib correlation	.24	Hereford	(86)
Intra-sire regression	.23	Hereford	(86)

Miscellaneous

Factor	Method	Heritability	Breed	Reference
Gain birth to weaning	Paternal half-sib correlation	0	Hereford	(48)
Gain birth to weaning	Paternal half-sib correlation	.45	Hereford	(48)
Days birth to weaning	Paternal half-sib correlation	.44	Milking Shorthorn	(30)
Height at withers		.41	Chiana	(18)
Lowness score	Dam-offspring regression	.46	Angus	(86)
Lowness score	Half-sib correlation	.30	Angus	(86)
Thickness score	Half-sib correlation	.10	Angus	(86)
Thickness score	Dam-offspring regression	.15	Angus	(86)
Smoothness score	Dam-offspring regression	.15	Angus	(86)
Smoothness score	Half-sib correlation	.18	Angus	(86)

Estimates of Repeatability

Weaning Weight

Method	Repeatability	Breed	Reference
Intra-class correlation	.21 to .61		(123)
Intra-class correlation	.43	Hereford	(12)
Correlation of adjacent calves	.25 to .62		(123)
Correlation of adjacent calves	.50	Hereford	(48)
Correlation of adjacent calves	.49	Hereford	(12)
Correlation of adjacent calves	.52	Hereford	(81)
Correlation of adjacent calves	.48	Hereford	(114)

Weaning Score	Repeatability	Breed	Reference
Intra-class correlation	.04 to .39		(123)
Correlation of adjacent calves	.09 to .28		(123)
Gain			
Birth to weaning	.38	Hereford	(12)
Birth to four months	.34	Hereford	(114)
Condition Score			
Intra-class correlation	.04 to .51		(123)
Correlation of adjacent calves	.19 to .45		(123)

Correlations - Weaning Factors

	Method	Breed	Correlation	Reference
Weaning Weight With:				
Birth weight		Herefords	.27**	(48)
		Herefords	.60**	(48)
Weaning score		Herefords	.68**	(76)
	Phenotypic		-.16**	(116)
Gain in feed lot	Total		-.059	(67)
	Intra-year		.088	(67)
	Intra-year		.28	(80)
First winter gain	Intra-year and -sex		.06	(65)
Summer range gain	Intra-year and -sex		.08	(65)
Fall gain	Intra-year and -sex		-.06	(65)
Second winter gain	Intra-year and -sex		.15	(65)
Efficiency of gain in feed lot	Total		-.507**	(67)
	Intra-year		-.510**	(67)
Long yearling weight	Phenotypic		.59**	(116)
Long yearling grade	Phenotypic		-.05	(116)
Gain weaning to yearling	Phenotypic		.21*	(116)
Weaning Type Score With:				
Weaning weight	Intra-sire		.68	(76)
Feed lot gain	Intra-sire and -year		-.021	(32)
			.0	(73)
	Total		.09	(67)
	Intra-year		.025	(67)

Weaning Type Score With:	Method	Breed	Correlation	Reference
Efficiency of gain in feed lot	Total		-.172	(67)
	Intra-year		-.284**	(67)
Yearling gain	Intra-sire and-year		-.107	(32)
Long yearling weight			-.07	(116)
Slaughter grade	Intra-sire and -year		.234**	(32)
			.23	(80)
	Total		.310**	(67)
	Intra-year		.361**	(67)
Long yearling grade			.61	(116)
Gain weaning to yearling			-.12	(116)
Carcass grade	Total		.328**	(67)
	Intra-year		.206**	(67)
	Intra-sire and -year		.022	(32)
Gain Birth to Weaning With:				
Birth weight			.07	(48)
			.44**	(48)
Gain in feed lot	Total		.029	(67)
	Intra-year		.090	(67)
			0	(28)
			.12	(136)
Efficiency of gain in feed lot	Total		-.362**	(67)
	Intra-year		-.412**	(67)

Correction Factors

Age

The growth curve of suckling calves is nearly a straight line from birth to 155 days and from 155 to 225 days (62). Calculations have shown that the regression coefficient of weaning weight and weaning age is positively correlated with the average weight from which the regression was calculated (83). The equation chosen for correcting weaning weight to a standard age is:

$$W = ru + db$$

W = corrected weight
ru = weight at weaning
d = age at weaning
b = regression coefficient

From this formula a nomograph was formulated:

$$b = .0069W - 1.525.$$

Weaning weights were also adjusted to a 210-day age by the following formulas (12):

$$\text{Age intercept} = \text{average age} - \frac{(\text{average weaning weight})}{(\text{regression coefficient})}$$

$$\text{Corrected weaning weight} = \text{actual weight} \times \frac{(\text{standard age} - \text{age intercept})}{(\text{actual age} - \text{age intercept})}$$

For experimental animals with 28-day weights bracketing the standard age, prorating gain appears to be suitable (20).

Some of the regressions of weight on age that have been determined are as follows:

Pounds per Head per Day		Reference
1.28	Between ages of 25 and 35 weeks	(117)
2.27	176-day weight	(81)
1.33	205-day weight	(83)
1.67		(19)
1.17		(92)
1.46	210-day weight	(12)

Sex

Studies with the University of California purebred Hereford herd indicated that heifers attained approximately one-half of their mature weight at 12 months, bulls at 15 months.

Heifer weights were 97 percent those of bulls at 1 month, 89 percent at 4 months, 87 percent at 8 months, 77 percent at 12 months, and 65 percent at maturity (49).

Some of the correction factors that have been determined are:

Add to the Weight of Heifers (lbs.)	Age		Reference
22	6 months	to equal steers	(68)
32	205 days	to equal steers	(82a)
24.6	210 days	to equal steers	(12)
2		to equal steers	(19)
25		to equal steers	(92)
22		to equal bulls	(19)
25	210 days	to equal bulls	(21)
68	240 days	to equal bulls	(114)
44	176 days	to equal bulls	(81)

Sex differences did not vary significantly among sires (82a).

Weight and Age of Dam

It is difficult to separate accurately the effects of weight from the effects of age. It was found that the regression of weaning weight of calf on weight of dam at 18 months of age was 0.10 to 0.13 (92). It must, therefore, be concluded that weight of dam at 18 months is an important factor in determining the weaning weight of the next generation.

The relationship of age of dam, weight of dam, and weaning weight of calves is shown in Table I.

TABLE I

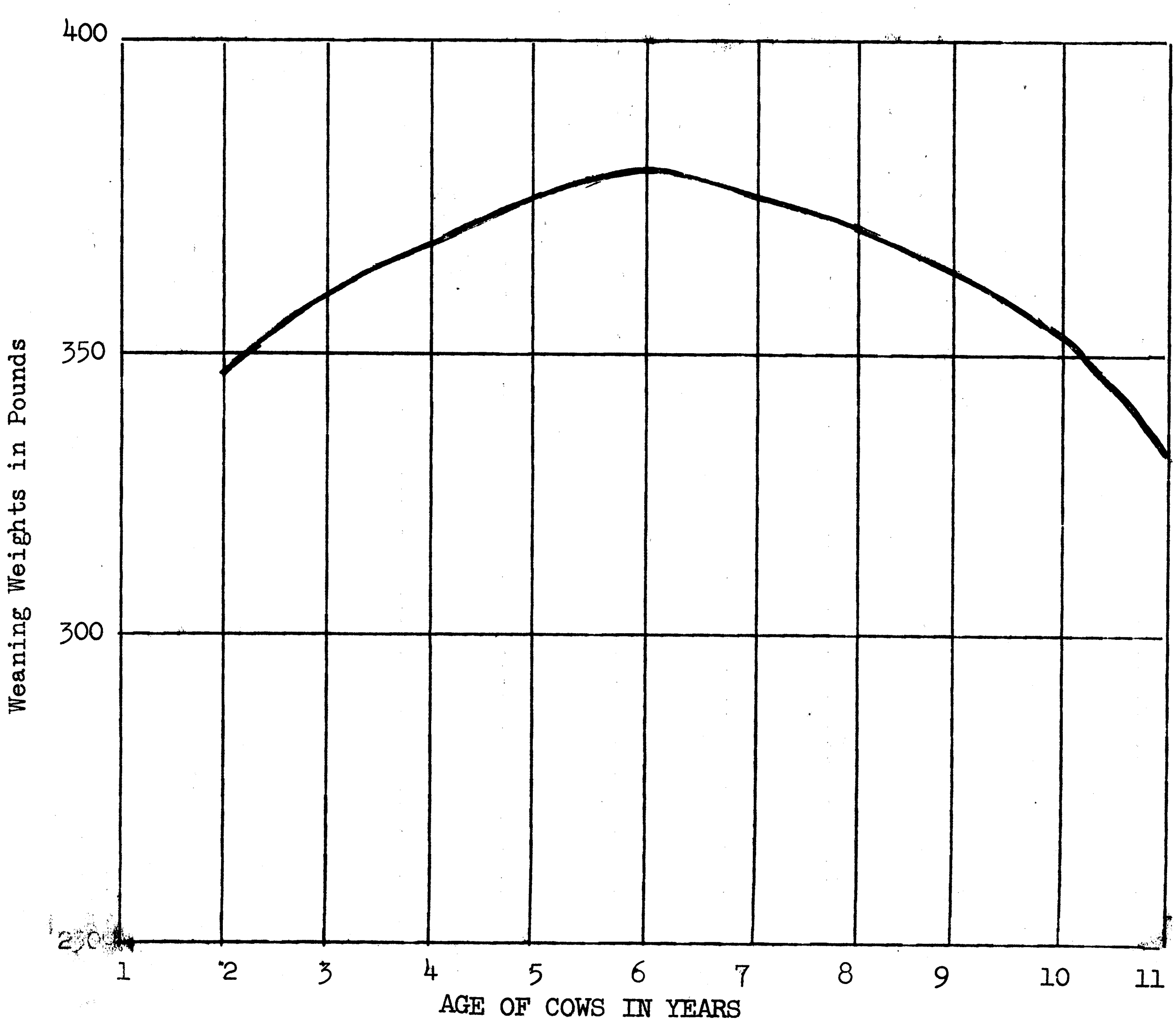
The Weights of Cows at Different Ages and the Weights of the Calves Produced (80).

Age of Cow (years)	Average Weight of Cow	Average Weaning Weight of Calves
3	908	387
4	952	405
5	983	429
6	1013	447
7	1024	454
8	1017	450
9	993	436
10	981	422

In general, the age-of-dam effect has been considered as a curve with maximum weaning weights expected from six-year-old cows, with a gradual decrease in the weaning weights from six to eleven years. A ten-year-old cow may be expected to produce about the same size calf at weaning as a two-year-old heifer (Table II).

TABLE II

Weaning Weights of Hereford Calves at 175 days of Age from Cows of Various Ages (68).



Some deviations from this pattern have been noted. Calves from five- to nine-year-old cows have been 35 pounds heavier than from three-year-old cows (21). Calves at 30 weeks of age were 75 pounds lighter from two-year-old cows than from mature cows. The weaning weight of the calves actually increased with increasing age of dam through eight years but then declined (117). If cows five years old and over are considered mature, the calves from three-year-old cows will be 35 pounds light and from four-year-old cows 15 pounds light at weaning (12).

Marked deviations from the usual nutritional or selection standards may influence the effect of age of dam on weaning weight of the calf (19)(113).

Correction factors for sex and age of dam for calves four months and eight months of age have been tabulated (Tables III and IV).

TABLE III

Correction Factors Used in Standardizing Growth
Rate from Birth to 4 Months of Age (114)

Correction	Class	Lb. Gained per Day to be Added	
	Bull Calves	--0--	
Sex	Heifer Calves	.13	
Age of dam		Male Calves	Heifer Calves
in terms of	1st calves	.20	.14
calving sequence	2nd calves	.13	.09
	3rd calves	.07	.05
	4th calves	.03	.02
	5th-8th calves	--0--	--0--
	9th calves	.05	.03
	10th calves	.10	.07
	11th calves	.17	.12
	12th calves	.25	.17

TABLE IV

Correction Factors Used in Standardizing
Weaning Weight (240 Days) (114)

Correction	Class	Lb. to be Added	
	Bull Calves	--0--	
Sex	Heifer Calves	68	
Age of dam		Male Calves	Heifer Calves
in terms of	1st calves	26	18
calving sequence	2nd calves	18	11
	3rd calves	11	5
	4th calves	6	0
	5th-8th calves	0	0
	9th calves	4	7
	10th calves	8	13
	11th calves	14	21
	12th calves	19	31

Inbreeding

If sires and inbreeding of dam were ignored, the intra-year regression was -0.74 lb. per one percent inbreeding of the calf. When years and inbreeding of dam were controlled statistically, the effect of inbreeding of calf was -1.19 lbs. per one percent inbreeding (92). A regression of -1.75 lbs. per one percent inbreeding of calf also has been reported (19), and a regression of -.48 pound has been noted (81).

The effect of inbreeding of the dam appears a bit confusing. A regression of 0.95 pounds increase in weaning weight of calf per one percent increase in inbreeding of dam has been found (92), while a regression of -1.15 pounds also has been reported (19). Inbreeding has no apparent effect on type score (92).

Effect of Nutrition on Weaning Performance

Liver storage of vitamin A and carotene in newborn calves did not appear to be related to the liver storage or carotene intake of the dam during gestation (4).

The liver storage of vitamin A in the calves at three months of age appears to be closely related to the dam's dietary intake of carotene during lactation, but not influenced by her liver storage of carotene and vitamin A (4)(6).

Mobilization of stored vitamin A and carotene by lactating cows on a low plane of carotene intake was inadequate to provide sufficient vitamin A for the calf (6).

The first two months after birth are most critical with respect to the vitamin A nutrition of the calf (4).

A choline deficiency in the calf results in a marked weakness, renal hemorrhage, and fatty liver (119).

Dietary sources of B vitamins are necessary for young ruminants before the microflora of the rumen start to function (119).

A deficiency of vitamin A in the ration of the young bovine produces an increased cerebrospinal fluid pressure. The increased cerebrospinal fluid pressure is accompanied by papilledema, nyctalopia, syncope, and incoordination. On return to normal diet the cerebrospinal pressure slowly returns to normal, while the various disturbances disappear (95).

Vitamin E deficiency has caused serious loss in calves from a few days to three months old. The animals show varied symptoms, but the muscles are usually affected (58).

Oral administration of 40 mg. or more of cobalt daily per 100 pounds body weight produced toxic effects in calves (36).

Calves born from animals unadapted to tropical climates are small, grow slowly, and cannot make effective use of the mother's milk (11).

Newborn animals have the ability of absorption, without change of certain globulins of the colostrum (27). The epithelial cells of the ileum contain vesicles which disappear 63 to 65 hours after birth. These vesicles are definitely associated with the absorption of protein without change.

Calves placed on synthetic milk rations developed paralysis. If untreated, death resulted 12 to 24 hours after the appearance of initial symptoms. Oral administration of a potassium salt or subcutaneous injection of biotin cured the animals (39).

Under range conditions, the symptoms of vitamin A deficiency are dead or weak calves, severe diarrhea in weak, newborn calves, and eye lesions (54).

In very early growth, about 0.04 lb. of phosphorus is required for each pound of protein required (94).

Beef cows receiving a carotene allowance equivalent to 60 µg. per pound of body weight were unable to maintain liver stores or plasma vitamin A levels during the last six months of gestation. When the carotene allowance was increased to 333 µg. during lactation, liver stores and plasma vitamin A were increased (3).

The practice of developing show bulls on nurse cows frequently results in a syndrome known as "show-founder". It develops progressively through a chain of symptoms including laziness, stiffness, lameness, misshapen bones, enlarged joints, eroded articulating surfaces of bone, and often sterility. It was concluded that milk feeding resulted in some sort of stimulus to the lymphatic rather than the reticuloendothelial system (132).

Growth

In terms of weight for age, growth of calves is linear from two months to ten months of age and from ten months to 24 months (16). The monthly gain of calves increases from birth to five months of age, when the gain is the most rapid during the life of the animal. From this age it declines to the age of 15 months, followed by a second cycle with a maximum gain at about 20 months of age (15).

The growth mechanism and the genetic factors affecting the calf for the period from birth to four months are significantly different from and independent of the mechanism and genetic factors operating for the period from four months to weaning. A possible explanation for this may be that the principal variation in genotype for rate of growth for the period birth to four months may be concerned with the calf's vigor and adaptability to postnatal conditions, while for the period four months to eight months genotypic differences for ultimate size and rate of maturity may be the principal source of genetic variation in rate of growth (115).

In a study with identical twin calves from three to seven months of age inclusive, it was found that the extremely close agreement between calves indicated that early body size and growth rate were dependent almost entirely on genetic constitution and easily controllable environment and not upon unexplainable or chance factors (23). In another study with identical twins, it was concluded that the heredity and not the intensity of feeding determines the bodily development at maturity (52). Nutritionally, the extent of skeletal growth was affected much less than the extent of growth in weight. The curves for growth in height of full-fed animals nearly coincide with the curve of poorly fed animals (16). In a study of the growth of young calves, it was observed that the head and legs are proportionally large in the calf, and as the beef qualities develop they become proportionally smaller (51).

Skeletal growth is more regular than growth in weight. Growth of the head and of the leg bones seems not to be checked by scanty feed. There does appear to be some effect of scanty feed on growth of pelvic bones, body length, and chest depth (89).

In an experiment using identical twin heifer calves, the twins were divided into four groups. In all groups, one twin of each pair received a normal plane of nutrition according to age and growth capacity while the other twin received 60, 80, 120, and 140 percent, respectively, of that amount. The following results were obtained (53):

(a) No differences in the various twin pair reactions to the different feeding levels could be demonstrated in spite of the great differences in the type of twins used.

(b) Rearing intensity has practically no influence on size and proportion of the animal body at maturity.

Lactation

The recommended nutrient allowances during lactation for beef cows of 900 to 1100 pounds are as follows (91):

Daily feed, lbs.	28
TDN, lbs	14
Digestible protein, lbs.	1.4
Carotene, mg.	300
Calcium, gm.	30
Phosphorus, gm.	24

Heifer calves wintered on high, medium, or low levels showed no significant or consistent difference in average weaning weight of their calves (104)(105)(141). A supplement of cottonseed cake on native range in the winter did have some effect on the average weaning weight of the calves, although average differences were small (7). Identical twins were used to study the effects of extreme underfeeding on lactation (41). If the animals were underfed for ten weeks prior to calving they did produce less milk, although the composition of the milk and butterfat were not affected. This underfeeding did not affect production and lactation in later calvings. In another study with identical twins one heifer was grain fed and the other normal fed. The fattened heifer failed to milk as much or as long as the normal heifer (127).

The amount of winter gain made by cows, except in the case of young cows, has little or no effect upon the birth or weaning weight of their calves (131).

Beef heifers show more weight loss during lactation than do dairy heifers (64).

A study of the thyrotropic hormone content of beef and dairy cattle pituitaries showed that those from lactating nonpregnant dairy cattle contained 30 percent more, lactating and pregnant 17 percent more, and dry nonpregnant 60 percent more hormone than the corresponding classes of beef cattle (129).

Body measurement data do show that lactation retards the growth in young females (118).

No specific injurious effects upon heifers were noted due to feeding alfalfa hay exclusively from six months of age through two lactation periods (107).

Animals were maintained indoors through five generations to determine the effects of lack of sunlight on production (100). These animals had less vitamin D in their milk than animals in sunlight, but even after five generations there was no difference in the production or chemical composition of the milk.

Early calving does not affect the milk-producing ability of the heifers (107).

Holstein cows with mostly black coloring maintain milk flow during the hot season more persistently than Holstein cows that are about half black and half white (87).

There is a decrease of 73 pounds of milk and 2.3 pounds of butterfat for each one percent increase in inbreeding in Holstein-Friesian cows (130).

Some correlations are (99):

Daily milk production (lbs.)/week of lactation	.33
Daily milk production/ave. daily gain of calf	.44
Week of lactation/ave. daily gain of calf	-.50

Under extreme conditions a shortage of phosphorus becomes a limiting factor in the economical utilization of feeds and in the growth of cattle. Milk flow is reduced by the lack of phosphorus in the feed (35). Cows allowed access to native-grass pasture during the summer, and wintered on prairie hay and a protein supplement which provided a daily phosphorus intake of approximately ten grams per head, had a phosphorus intake adequate to meet the requirements for reproduction and lactation (96). In the Southwest range area, phosphorus supplementation has been shown to result in more and heavier calves and in better health of all animals. Disodium phosphate in the drinking water and fertilized pasture shows effects similar to self-fed bone meal (110).

High content of sodium chloride and calcium chloride in drinking water caused the inability to suckle the calf before any injury to the mother was apparent (55).

The importance of high milk production in beef cows in the production of calves seems to be overestimated. High milk production was not observed in a study of 57 Hereford, 12 Aberdeen-Angus, and 11 Shorthorn lactation records. Cows giving from 5 to 18 pounds of milk daily at peak production weaned calves weighing from 400 to 528 pounds at eight months. The maximum production of the beef cows designated as "high milk producers" by the herdsman reached a level of only 12 to 18 pounds daily. One cow that produced 25.9 pounds at the time of test during the first month had declined to a 15-pound level by the second month (43)(44).

The capacity of the calf for milk consumption during the first month of the dam's lactation may be a limiting factor in milk production in beef cows, the maximum production being determined by the calf's capacity. Cows with inherent abilities for high production cannot express such abilities since milk secretion is slowed down and must level off to the amount of milk that is removed from the udder daily.

The gross correlation between daily milk production of Hereford cows and the daily gain in weight of their calves was .60, .71, .52, and .35 for the 1st, 2nd, 3rd, and 4th months, respectively. The correlations between the two variables the following four months were not significant. Another indication of this low correlation is the fact that the average daily gain in weight of the calves was quite constant during the entire suckling period even though there was a gradual decline in milk production following the first month of lactation. Dams with extremely low milk records produced small calves at weaning time in a majority of the cases observed. Calves from low milk producing cows weaned 100 pounds lighter (8 months) than the calves from high milk producing cows.

The correlations between daily gain in body measurements in calves and daily milk records of their dams were somewhat lower than were the weight gains.

Genetic Factors

Inheritance of milk production in crosses of beef and dairy breeds is (45):

Angus	1066 lbs.
Jersey	3919 lbs.
Angus x Jersey	3493 lbs.

In beef and dairy crosses, the crossbred more nearly approaches the dairy parent in milk production.

The heritability of milk production in Milking Shorthorn cattle is (143)(144):

	Milk Production	Butterfat Production
Paternal half-sib	.284	.368
Intra-sire daughter-dam regression	.711	.839
Paternal half-sib correlation	.142	.245

A summary of experimental data on correlation of phenotypic characteristics with milk production has been published (122).

No advantage of Shorthorn roan color in milk production was found (109). The correlation between milk production and number of services for conception (dairy cattle) was -0.04 (13).

Possible negative correlation between milk production of dam and gain of progeny in the feed lot was reported (73).

In Herefords, a condition known as "fused teats" is inherited as a simple monofactorial recessive. There is a faulty placement of the fore and rear teats causing a fusion (61).

Some correlations in Holstein cattle are (122):

Milk yield/ body length	+0.59
Butter fat/ body length	+0.03
Butter fat/ body width	+0.07
Width lower jaw/ milk yield	-0.82

An analysis was made of 12 low- and 17 high-producing herds of Swedish Red-and-White cattle (59). Bulls of the same or related lines were used in all of these herds. Since all herds were descended from the same stock, it was considered that genetic differences between low- and high-producing groups were small and that the differences in production were due almost entirely to differences in feeding management. In the low-producing herds, none had an average annual yield higher than 124 kg. butterfat. In the high-producing herds, none averaged less than 145 kg.

	High-producing Herds	Low-producing Herds
Milk yield, heritability	0.39	0.32
Milk yield, repeatability	0.43	0.41
Percentage butterfat, heritability	0.68	0.54
Percentage butterfat, repeatability	0.64	0.59

This analysis does not support the contention that genetic differences in quantitative characters are more clearly manifested in an optimum than in a less favorable environment.

Factors Influencing Weaning Weight

Crossbreeding

In a comparison of Angus and native Arkansas cattle, the following results were obtained (120):

Mating	Average Daily Gain to Weaning (lbs).
Purebred Angus x Angus cows	1.59
Purebred Angus x (Angus x Native) cows	1.68
Purebred Angus x Native Arkansas cows	1.71
Native Arkansas x Native Arkansas cows	1.69

The weanling calves were produced considerably cheaper per head and per 100 pounds live weight from the small native Arkansas cows than from purebred Angus cows since the native cows were smaller and required less feed in winter than purebred cows (33). In a comparison of calves from native Mississippi cows mated to bulls of other breeds, the following results were obtained (135):

Bulls Used on Native Cows	Average Daily Gain Birth to Weaning (lbs).
Native	1.86
Polled Devon	1.80
Polled Shorthorn	1.80
Polled Hereford	1.67
Angus	1.64

Native cattle from North Carolina were mated to purebred Hereford bulls. The cows used were rangy, with long,narrow heads, flat, poorly covered loins, and noticeably lacking in proper development of the hind quarters. Many of these cows weighed less than 600 pounds (57). The calves from the Hereford x Native mating gained .14 lbs. more per day than native calves and weighed 53 pounds more at weaning. Purebred Hereford and Sussex sires when mated to native unimproved South African cows produced calves heavier than the progeny of Shorthorn, Angus, or Africkander sires (118). Hereford x Shorthorn heifers showed a weight advantage at weaning of 20 pounds over straight-bred Hereford heifers (2).

In a summary of eight years' study of crossbreeding beef cattle, the following weaning weights were obtained (42):

Mating	Daily Gain, Birth to Weaning (lbs)		Weaning Weight (lbs.)	
	Males	Females	Males	Females
Purebred Angus	1.80	1.59	486.2	419.7
Purebred Hereford	1.48	1.45	393.7	385.7
Hereford x Angus	1.79	1.70	472.6	446.9
Angus x Hereford	1.63	1.52	432.4	394.3

Experiments with crossbreeding using British and Brahman breeds have very consistently shown an advantage for the crossbred calves.

Average Weights of Females at Six Months of Age (1)

Breeding	Six Month Weight (lbs.)
Purebred Angus	293
Brahman x Angus	350
Angus x (Brahman x Angus)	392
(Brahman x Angus) x Angus	353
(Brahman x Angus) x (Brahman x Angus)	375
Africander x Angus	350
(Africander x Angus) x (Africander x Angus)	322

Average Weaning Weight of Steer Calves (1)

Breeding	Average Daily Gain to Weaning (lbs.)	Weaning Weight (lbs.)
Purebred Angus	1.28	404
Brahman x Angus	1.70	454
Angus x (Brahman x Angus)	1.61	444
Africander x Angus	1.64	444

Six Month Weaning Weight of Calves (111)

Breeding	Six Month Weight (lbs.)
Hereford x Hereford	316
Brahman x Hereford	354
Hereford x (Brahman x Hereford)	402
(Hereford x Brahman) x Hereford	390

Average Weaning Weight all Calves (89)

Breeding	Seven Month Weight (lbs.)
Herefords	373
Brahman x Hereford	383
Hereford x (Brahman x Hereford)	449

Effect of Breeding of Dam on Weaning Weight-of-Range Calves (101)

Breeding of Dam	Average Deviation of Weaning Calves from Mean (lbs.)
Grade English cows	-3.8
Less than one-half Brahman	+10.0
One-half Brahman	+23.0
More than one-half Brahman	+5.3
Native cows	-35.0

In crosses of inbred lines, the outbred calves showed an advantage of 18 percent in weaning weights. Thirty percent more outbred calves were raised to weaning (126).

Effect on Weaning Weight of Calves by Mating Angus Cows to Sires of Other Breeds (112)

Sire	Six Month Weaning Weight (lbs.)
Angus	325
Zebu	398
Africander	379

Miscellaneous Factors

Dark red calves were heavier at weaning. Yellow cows weaned heavier calves. These differences were not statistically significant (117).

Late calves showed an advantage in suckling gain (31).

Cows with longer gestation produced heavier calves at weaning (113).

In comparison of large type and compact type cattle, the large type cows wean heavier calves (80).

For each 100 pounds of increased weight in cows which weighed from 800 to 1200 pounds, there was an increase of 20 pounds in the weight of the calves at weaning time (131).

Early breeding does not affect the size of calves produced in subsequent years (139).

Blood Values of Cows and Calves

Calves:	Ca per 100 cc. serum	10.76 to 14.3	Ave. 13.0
	P per 100 cc. serum	3.64 to 8.49	Ave. 6.3 (100)

Distribution of White Blood Cells (132)

	Percent
Total neutrophils	19.66
Arneth Class I	1.55
Arneth Class II	5.35
Arneth Class III	9.29
Arneth Class IV	3.62
Arneth Class V	0.86
Total lymphocytes	75.31
Young	38.73
Mature	36.58
Monocytes	1.98
Eosinophils	2.32
Basophils	0.14
Atypical forms	0.59

Blood Glutathione of Cows and Their Newborn Calves (108)

	Glutathione (mg. percent)		
	Reduced	Oxidized	Total
All cows	38.29	6.79	45.08
Newborn calves	56.36	7.08	63.44
Newborn bull calves	55.53	6.09	61.62
Newborn heifer calves	57.19	8.07	65.26
Calves (no colostrum)	57.82	7.21	65.03
Calves (colostrum)	47.78	6.33	54.11

Blood Glucose and Acetone Bodies of Cows (88)

Item	Mg./100 ml. Blood
Normal- before parturition	
blood glucose	47
blood acetone bodies	2.7
Normal- post partum	
blood glucose	41
blood acetone bodies	6.3

Normal Values Carotene and Vitamin A in Four-month Hereford Heifer Calves (24)

	Mg./100 ml.
Blood plasma Vitamin A	2.7 to 7.2 Ave. 5.3
Blood plasma carotene	3.6 to 13.2 Ave. 8.7
	Mg./gm. dry matter
Liver vitamin A	1.2 to 6.0 Ave. 2.5
Liver carotene	0.0 to 1.5 Ave. 0.7

Phosphorus and Hemoglobin Values of Blood from Weanling Heifers (97)

Phosphorus, mg./100 ml. plasma	4.12 to 7.84
Hemoglobin, gm./100 ml. blood	9.8 to 11.4

Studies on the Haematology of Calves from Birth to One Year of Age (46)

(a) Coagulation time: 2 to 11 minutes. Appears slower between 20 and 35 weeks than before and after this period.

(b) Blood sedimentation rate: 1.0 mm. to 7.0 mm.

(c) Packed cell volume: corpuscular volume from 18.0 mm. to 61.0 mm., although most of the calves had values of 30.0 mm. to 50.0 mm.

(d) Haemoglobin contents: 4.60 to 16.05 gm. per 100 ml. of blood, majority of calves between 9.0 to 14.5.

(e) Erythrocyte count:

Age	Ave. (Millions per C. mm.)
Birth	7.4
One week	7.5
8 - 12 weeks	8.1
4 - 6 months	7.8
12 months	6.9

(f) Platelet count: 150,000 to 525,000 per C. mm.

(g) Lencocyte count: 6,500 to 11,500 per C. mm. blood.

(h) Neutrophil leucocytes: 6 to 64 percent. Average 25 percent.

(i) Lymphocytes: 34 to 85 percent.

(j) Monocytes: common range 12 to 14 microns. Percentage from 0 to 12 percent, average 3.6 percent.

(k) Eosinophil leucocytes: 8 to 15 microns. Percentage from 0 to 15 percent.

(l) Basophil leucocytes: none observed.

Vitamin A and Carotene Content of Blood Plasma of Dairy and Beef Heifers (98)

	Micrograms per ml. of Blood Plasma			
	Dairy Calves		Beef Calves	
Age in Days	Vitamin A	Carotene	Vitamin A	Carotene
1-20	12	22	16	26
21-40	10	23	13	18
41-60	10	50	13	23
61-80	12	44	16	43
81-100	12	48	16	52.
101-120	12	50	16	53
121-140	12	36		

Vitamin A content of the blood plasma of beef calves is appreciably higher than for dairy calves.

Vitamin A Blood Plasma Values in Cows and Calves on Deficient and Adequate Vitamin A Ration (4)

	Vitamin A (Mg./100 ml.)	
	Vitamin A Deficient	Adequate Vitamin A
Cows:		
Plasma, at calving	11.32	16.30
Plasma, 2 week lactation	11.1	17.7
Plasma, 3 month lactation	13.3	23.5
Calves:		
Plasma, at birth	3.06	4.13
Plasma, 2 weeks	6.19	14.40
Plasma, 3 months	4.10	11.90

Cows receiving a supplement of vitamin D showed increased D in the blood. No difference was found in the D content of blood plasma and liver (34).

Milk Composition

Comparative Composition of Blood Plasma and Milk of the Cow (91)

Blood Plasma Composition	Percent	Milk Composition	Percent
Water	91.0	Water	87.0
Glucose	0.05	Lactose	4.90
Serum Albumin	3.20	Lactolbumin	0.52
Serum Globulin	4.40	Lactoglobulin	0.05
Amino acids	0.003	Casein	2.90
Neutral fat	0.06	Neutral fat	3.70
Phospholipids	0.24	Phospholipids	0.04
Cholesterol ester	0.17	Cholesterol ester	trace
Calcium	0.009	Calcium	0.12
Phosphorus	0.011	Phosphorus	0.10
Sodium	0.34	Sodium	0.05
Potassium	0.03	Chlorine	0.11
Chlorine	0.35	Potassium	0.15
Citric acid	trace	Citric acid	0.20

Percentage Composition of Milk of Different Species (91)

Species	Water	Protein	Fat	Lactose	Ash	Calcium	Phosphorus	Calories
Cow	87.2	3.5	3.7	4.9	0.72	0.121	0.095	74
Sheep	82.7	5.5	6.4	4.7	0.92	0.201	0.168	109
Goat	86.5	3.6	4.0	5.1	0.81	0.131	0.104	79
Mare	89.0	2.7	1.6	6.1	0.51	-	-	54
Sow	82.0	6.2	6.8	-	0.96	0.252	0.151	113
Woman	87.5	1.0	4.4	7.0	0.21	0.035	0.013	70
Bitch	75.4	11.2	9.6	3.1	0.73	-	-	163

The Folic Acid and Vitamin B_{12} Content of Milk of Dairy Cattle (26)

	Micrograms per liter	
90-150 days post partum:	Vitamin B_{12}	Folic Acid
Mean	6.6	1.3
Range	3.2 - 12.4	0.20 - 4.0

Vitamin Content of Colostrum of Milk of the Cow (102)

	Micrograms per ml.	
Vitamin	Colostrum	Milk
Thiamine	0.62	0.38
Riboflavin	6.10	1.77
Nicotinic acid	0.96	0.91
Pantothenic acid	2.24	3.67

	Micrograms per ml.		
Days after parturition	Thiamine	Riboflavin	Pantothenic acid
0	0.58	5.69	1.73
1	0.59	3.53	3.20
2	0.59	2.67	3.96
3	0.59	2.32	4.24
4	0.58	2.03	4.01
5	0.59	2.03	4.05
6	0.58	1.93	4.19
7	0.57	1.87	4.29
8	0.56	1.87	4.38
9	0.56	1.89	4.16
30	0.38	1.83	3.82

Some Vitamin and Trace Elements Found in the Colostrum of the Beef Cow (90)

Item	Value
No. samples	6
Fe (mg./kg.)	1.80 (1.30-2.50)
Cu (mg./kg.)	0.40 (0.30-0.60)
Co (mg./kg.)	0.006 (0.004-0.011)
Carotene (g./100 ml.)	129 (70-233)
Vitamin A (g./100 ml.)	145 (54-225)
Thiamine (g./ml.)	0.85 (0.64-1.00)
Ribovlavin (g./ml.)	4.98 (3.22-6.75)
Pantothenic acid (g./ml.)	1.71 (0.69-3.20)
Nicotinic acid (g./ml.)	0.57 (9.43-0.61)

Colostrum from Angus cows had higher carotene and vitamin A than colostrum from Shorthorns or Herefords (90).

Colostrum of beef and dairy cows is similar as to iron, copper, and cobalt content (90).

The ascorbic acid value of cows' milk is 15.4 - 18.4 mg. per litre (56).

The average fat content of the milk of the water buffalo is 7.5 percent (103).

Milk Vitamin A Values from Cows on Inadequate and Adequate Vitamin A Rations (4).

	Vitamin A (mg./100 ml.)	
	Deficient Ration	Adequate Ration
Milk, at calving	45.56	90.56
Milk, 2-week lactation	4.9	7.7
Milk, 3-month lactation	2.8	4.5

Two groups of grade Hereford cows were grazed on dormant range typical of southern New Mexico and given a supplemental feed during the precalving and calving periods. The energy and digestible protein of the supplemental feed were approximately the same for both groups, but one group received additional carotene from dehydrated alfalfa meal (134).

The blood carotene of the cows fed cottonseed meal was well above the requirements as shown by various workers, indicating no major deficiency over an eight-year period even in the most critical season.

An important observation of this project is that the feeding of the mixture, containing 23 percent dehydrated alfalfa meal, did not raise the plasma carotene over that of the cows fed no extra carotene. There was no significant difference in the plasma carotene and vitamin A results for the two groups.

The chemical composition of milk of animals suffering from aphosphorosis is not necessarily abnormal, but the "inorganic phosphorus" fraction of the blood may drop to a quarter of the normal level even before the disease can be diagnosed clinically. Other phosphorus compounds of the blood remain practically normal (128).

A supplement of vitamin D increased the colostral storage of D (34).

The vitamin A and carotene content of milk appears more closely related to dietary intake during lactation than do liver stores (6).

Creep Feeding

Pounds of Total Digestible Nutrients Required Daily by Beef Calves Weighing 200 to 500 Pounds to Maintain Weight and to Make Regular Daily Gains (138)

Weight of Animal	TDN Required (pounds)					
	To maintain wt.	1/2 lb.	3/4 lb.	1 lb.	1-1/2 lbs.	2 lbs.
200	1.9	2.6	3.0	3.4	4.2	-
300	2.5	3.5	4.0	4.5	5.5	6.5
400	3.0	4.2	4.8	5.4	6.6	7.8
500	3.5	4.9	5.6	6.3	7.7	9.1

Daily Average of Nutrients Consumed, Total Nutriment, and Nutriment to One Pound Gain During Each 100 Pounds Increase in Weight (50)

Weight From	Weight To	Dry Matter (lbs.)	Protein (lbs.)	CHo (lbs.)	Fat (lbs.)	N.R. 1:	Total Nutriment	Nutriment to 1 lb. Gain
100	200	2.60	.437	1.336	.143	3.8	2.094	2.25
200	300	6.10	.708	3.154	.161	5.0	4.224	3.19
300	400	8.13	.773	4.161	.219	6.0	5.427	3.76
400	500	9.81	.867	5.032	.259	6.5	6.482	4.29

Metabolism of Steer Which Nursed Twice Daily and Received Grain and Hay Immediately after Nursing (17)

Age (days)	Weight (kgs.)	Heat Production in 24 Hrs. (cal.)
100	63.5	2794
130	78.9	3382
170	108	4343
220	161	5947
275	197	5050

Metabolism of Heifer Which Nursed Twice Daily and Received Grain and Hay Immediately After Nursing (17)

Age (days)	Weight (kgs.)	Heat Production in 24 Hrs. (cal.)
100	59.9	2475
128	74.4	3974
167	101	4094
220	146	5174
276	189	5875

Estimated Average Requirements of Minerals by Growing Calves (93)

Age (days)	Weight (kgs.)	Heat Production in 24 Hrs. (cal.)
Calcium	0.27	Percent of dry ration
Phosphorus	0.19	Percent of dry ration
Magnesium	0.07	Percent of dry ration
Cobalt	0.07	p.p.m.
Copper	3	p.p.m.
Iodine	0.09	p.p.m.

Grain and hay were fed individually to calves during the suckling period. The following correlations were obtained (69):

Daily gain/ quantity of milk	0.517**
Daily gain/ quantity of grain	0.209
Quantity of milk/ quantity of hay	0.388**
Quantity of milk/ quantity of grain	0.142

Multiple Correlations:

Daily gain/ quantity of milk and grain	0.591**
Daily gain/ quantity of milk and hay	0.624**

Partial Correlation:

Daily gain/ quantity of milk (grain and hay constant)	0.619**

Calves learn very early to follow their mother and to feed at the same time and on the same feeds as does the mother (25).

Sixty-two Angus and Hereford calves were weaned at 90 or 180 days of age and fed individually until 370 days of age. Heifers weaned at 90 days of age were lighter in weight at 180 days than those weaned later, but were of similar weight at one year of age. Apparently, 90-day weaning does not adversely affect beef calves (47). Calves require about 10 pounds of whole milk per pound of gain (137). Where milk is scarce, calves large at birth have an advantage over small calves.

Under conditions of acute feed shortage, creep feeding young calves may have advantages (63)(106): (a) dams not so badly suckled down, (b) young animals develop more size and shrink less at weaning time.

Conditions of drouth or heavy stocking may penalize the daily gain of suckling calves as much as a pound a day during certain periods (142). Calves still suffered from the effects of this setback at 12 and 18 months of age. Animals that received 70 percent of the recommended allowances for growing dairy calves were delayed 12 to 14 weeks in sexual maturity compared to calves receiving recommended allowances (40).

Calves which received 2.85 lbs. of concentrate per day for 120 days while nursing gained 1.83 lbs. per day, while those on pasture alone gained 1.44 lbs. per day (14). Differences of .46 lb. per day in favor of creep fed calves also have been noted (60). Shelled corn, oats, and cottonseed pellets are good feeds for creep feeding (63). Feeding pellets containing 125 I.U. of vitamin A, 25,000 I.U. of vitamin D and 250 milligrams of niacin at birth showed no advantage in reducing colds, pneumonia, scours, and death losses (37).

Selection for Weaning Weight

There may be more opportunity for making progress by considering size and milk production within a breed rather than by crossing beef breeds of the same size (42). The sire has very little effect on weaning performance (135). Twenty percent of the variance in weaning weight was due to cow influence. Sire effect is about 14 percent of the variation (68). The lactating ability of a cow makes a major contribution to the growth of the calf throughout the entire suckling period (114).

Results indicate that considerable progress can be made in selecting cows on the basis of their first records, particularly by using weaning weights (12). If cows were separated into high- and low-producing groups, it was found that subsequent calves from the high-producing group produced calves 31 pounds heavier than the low-producing group (21).

The repeatability of weaning weight from range Hereford cows is high enough to permit reasonably accurate selection of cows for high lifetime production on the basis of the first calf weaned (81).

Efforts to predict the producing ability of cows on the basis of appearance have been disappointing (82).

Sires producing fast gaining (birth to weaning) calves at one station tended to do the same at another station (140).

Progress can be made in production by using weight and grade records at weaning to select replacements and to cull (38).

Weight of Calves Produced by Three-Year-Old Heifers Compared to Average Weight of Their Next Four Calves (82)

Group	Calves in Group (percent)	Ave. Weight of First Calf (lbs.)	Ave. Weight of Next Four Calves (lbs.)
I	8	321	404
II	22	349	417
III	37	383	430
IV	23	409	443
V	10	441	456

When the cows are grouped according to the weight of their first calves, it is shown that the three-year-old producing light first calves later produces below-average calves.

Weaning Data (84)

	Correlation	
	Weight	Grade
First year's calf and:		
second	.66	.24
average of 2nd and 3rd	.53	.39
average of 2nd, 3rd, and 4th	.51	.40
average of 2d, 3d, 4th, and 5th	.53	.42
Average of first two calves and:		
third	.54	.46
average of 3d and 4th	.55	.60
average of 3d, 4th, and 5th	.59	.69

The data indicate that considerable progress can be made in selecting breeding cows on the basis of the first calf record.

The following selection procedures are suggested (29):

(a) Retain a high percentage of heifers for one or two calf crops and select those which demonstrate their ability to wean heavy calves for further use in the herd.

(b) Select sires from among the sons of cows which have repeatedly demonstrated their ability to wean heavy calves and are the grandsons of bulls whose daughters have on the average produced heavy calves at weaning.

(c) Where possible, use sires whose daughters have proved to have good maternal abilities.

Difference in Weaning Weight Necessary to be Considered Significant (P = .05) for Various Numbers of Animals in Each Sire Group (67)

Number of Animals in Each Sire Group	Weaning Weight (lbs.)
2	67
3	54
4	47
5	42
6	38
7	36
8	33
9	31
10	30
12	27
14	25
16	24
18	22
20	21
30	17

Weaning and yearling weights and grades, and yearling gains of range cattle were studied to determine the genetic relationships that exist among them (10):

	Weaning Wt.	Weaning Grade	Yearling Wt.	Yearling Grade
Weaning grade	-			
Yearling weight	+	-		
Yearling grade	-	+	-	
Yearling gain	+	-	+	-.

Estimated Change that Occurs in Yearling Factors with Selection for Weaning Weight and Weaning Grade (10)

Basis of Selection	Average Superiority of Both Parents	Related Trait in Offspring	Estimated Change
Weaning weight	20 lbs.	weaning grade	minus -.2 units
" "	20 lbs.	yearling weight	plus 6 lbs.
" "	20 lbs.	yearling grade	minus 0.2 units
" "	20 lbs.	yearling gain	plus 10 lbs.
Weaning grade	1 unit	yearling weight	minus 20 lbs.
" "	1 unit	yearling grade	plus 0.4 units
" "	1 unit	yearling gain	minus 6 lbs.

The genes that control growth at one period probably are the same, or include a portion of the same, genes which influence growth at a later period. The negative genetic relationship between grade at different periods and size or gain is real. Among the factors which constitute high grading beef, compactness is one of the major considerations (116).

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